Appendix 1 Lens distortion removal code

```
pro lens_correct_1

;This IDL script will take out the lens distortions in an image file by
;using the calibration coefficients from a lens/camera calibration.
;Typically the coefficients describe a systematic radial distortion (K1 and K2)
;and an asymmetric component (P1 and P2)

;you change the file path names and the other variables
;to your own parameters.

;Please acknowledge Darren Turner and Richard Mount, School of Geography and Environmental
Studies
;University of Tasmania, 2004.
;Contact Richard.Mount@utas.edu.au for further information

read_jpeg,"D:\data_local\nwb\nwb3_sf\01_lens_distorted\0470c.jpg",image
help,image

;Mount: canon eos D30
result=bytarr(3,2270,1640)
infilled=bytarr(3,2270,1640)

;Grenness: Cygnascope originaly 640x480
;result=bytarr(3,900,600)
;infilled=bytarr(3,900,600)

;result=bytarr(3,2160,1440)

;Calibration coefficients from a lens/camera calibration.
;The coefficients describe a systematic radial distortion (K1 and K2)
;Mount: Canon eos D30
K1 = -1.67885E-04
K2 = 2.359517E-07

;and asymmetric components (P1 and P2)
P1 = -3.076152E-05
P2 = 1.174944E-05

;Mount: for a 10.5 micron pixel
; This converts from pixels to mm
xpnt2mm = 0.010509
ypnt2mm = 0.010486

;Grenness: for a 25 micron pixel
;xpnt2mm = 0.025
;ypnt2mm = 0.025

;Mount: Principal Point - preferably the optical one, if not known then use image centre
;xp = 2160.0/2.0
xp = 1093.0
;yp = 1440.0/2.0
yp = 720.0

;Grenness: Principal Point - preferably the optical one, if not known then use image centre
```

```
;xp = 640.0/2.0
;yp = 480.0/2.0

;Convert pixels to mm
xp=xp*xpnt2mm
yp=yp*ypnt2mm

;create the r variable ie radius from principal point
r=0.0

;Asymmetric correction part of the formula only
;+ (2*P1*((xc-xp)*(yc-yp))) + (P2*(r+(2*((xc-xp)^2))))
;+ (2*P2*((xc-xp)*(yc-yp))) + (P1*(r+(2*((yc-yp)^2))))

;Mount: canon eos d30 (ie 2160x1440)
for x = 0.0,2159.0 do begin
	for y = 0.0,1439.0 do begin

;Grenness: Cygnascope (ie 640x480)
;for x = 0.0,639.0 do begin
;	for y = 0.0,479.0 do begin

		xc=x*xpnt2mm
		yc=y*ypnt2mm

		r = sqrt(((xc-xp)^2)+((yc-yp)^2))

		xadj = ((xc-xp)*(K1*r^2 + K2*r^4)+ (2*P1*((xc-xp)*(yc-yp))) + (P2*(r+(2*((xc-
xp)^2)))))/xpnt2mm
		yadj = ((yc-yp)*(K1*r^2 + K2*r^4)+ (2*P2*((xc-xp)*(yc-yp))) + (P1*(r+(2*((yc-
yp)^2)))))/ypnt2mm

		;use these next variables to move the image into the middle of the output image
		;as the distortions usually mean the image will "grow" beyond its old dimensions
		out_x=x+50.0-xadj
		out_y=y+50.0-yadj

;		if out_x ge 0.0 and out_x le 2159.0 and out_y ge 0.0 and out_y le 1439.0 then
result(*,out_x,out_y)=image(*,x,y)
		result(*,out_x,out_y)=image(*,x,y)
	endfor
if x mod 100 eq 0 then print,x
endfor

;This section will infill the stretched apart image by using a kernal that takes the
;mean of all the good or valid pixels surrounding each non-valid or null (ie value = 0) pixels
;and gives that mean value to the middle non-valid pixel

infilled=result
area=bytarr(3,3)

;Mount
for x = 1,2268 do begin
	for y = 1,1638 do begin

;Grenness
;for x = 1,898 do begin
;	for y = 1,598 do begin
		if result(0,x,y) eq 0 then begin
			area(*,*) = result(0,x-1:x+1,y-1:y+1)
```

```
                                goodpix=where(area ne 0)
                                if goodpix(0) ne -1 then
infilled(0,x,y)=total(area(goodpix))/n_elements(goodpix)
                                area(*,*) = result(1,x-1:x+1,y-1:y+1)
                                goodpix=where(area ne 0)
                                if goodpix(0) ne -1 then
infilled(1,x,y)=total(area(goodpix))/n_elements(goodpix)
                                area(*,*) = result(2,x-1:x+1,y-1:y+1)
                                goodpix=where(area ne 0)
                                if goodpix(0) ne -1 then
infilled(2,x,y)=total(area(goodpix))/n_elements(goodpix)
                        endif
            endfor
            ;this next bit is simply to show progress
            if x mod 100 eq 0 then print,x
endfor

;infilled_up = reverse(infilled,2) <- this didn't work

;The "meshed" image is the result without the infilling
write_jpeg,"D:\data_local\nwb\nwb3_sf\02_lens_corrected\0470c_lenscorr_meshed.jpg",result,/true,
quality=100
write_jpeg,"D:\data_local\nwb\nwb3_sf\02_lens_corrected\0470c_lenscorr.jpg",infilled,/true,quality
=100

;write_jpeg,"D:\enviwork\grenness\cg5-6_lenscorr_meshed.jpg",result,/true,quality=100
;write_jpeg,"D:\enviwork\grenness\cg5-6_lenscorr.jpg",infilled,/true,quality=100

print, "another one bites the dust"
end
```

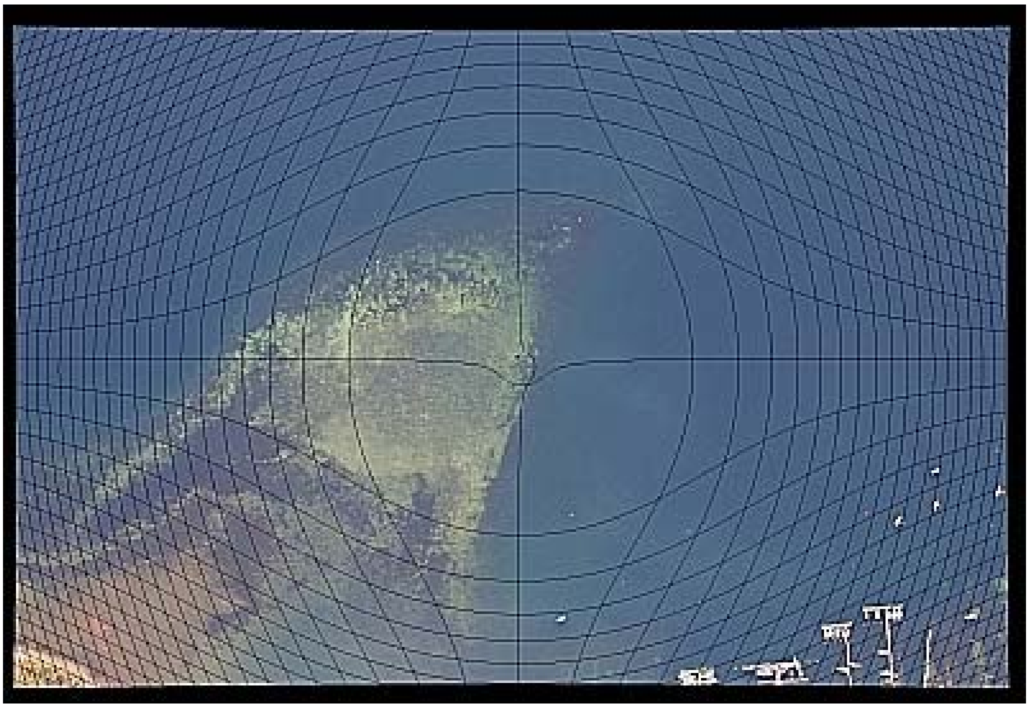


Figure A1-1. Example of the meshed image output showing the distribution of lens distortions

Appendix 2 Example of an aerial photography flight plan

Table A2-1. North West Bay flight plan for Run 7.

Project Name =	**TAFI NWB5**	
Coordinate System =	AMG66	
Datum =	AGD66	
Zone =	55	
Camera Type =	Digital	
Camera Brand =	Canon EOS D30	
Lens Type =	**NORMAL ANGLE**	
Focal Length =	24	mm
Filter =	nil	
Film =	na	
Negative/CCD Size X (long side) =	22.7	mm
Negative/CCD Size Y (short side) =	15.1	mm
Run 7:		**units**
Photo Scale =	40,000	ratio
Approx **Flying Height** =	960.0	m
=	3,150.0	ft
Photo (Frame) **Length** (X) =	908	m
Forward Overlap (Endlap) =	60.0	%
=	545	m
Forward Advance =	40	%
Photo Centres (Base) =	363	m
Photo (Frame) **Width** (Y) =	604	m
Sidelap =	30	%
=	181.2	m
Approx Time tween Exposures =	0.0	secs
@ plane ground speed =	150	km/hr
Total Model Length =	630	m
Total Coverage Length =	744	m
No. of Photos =	**0.0**	**0**

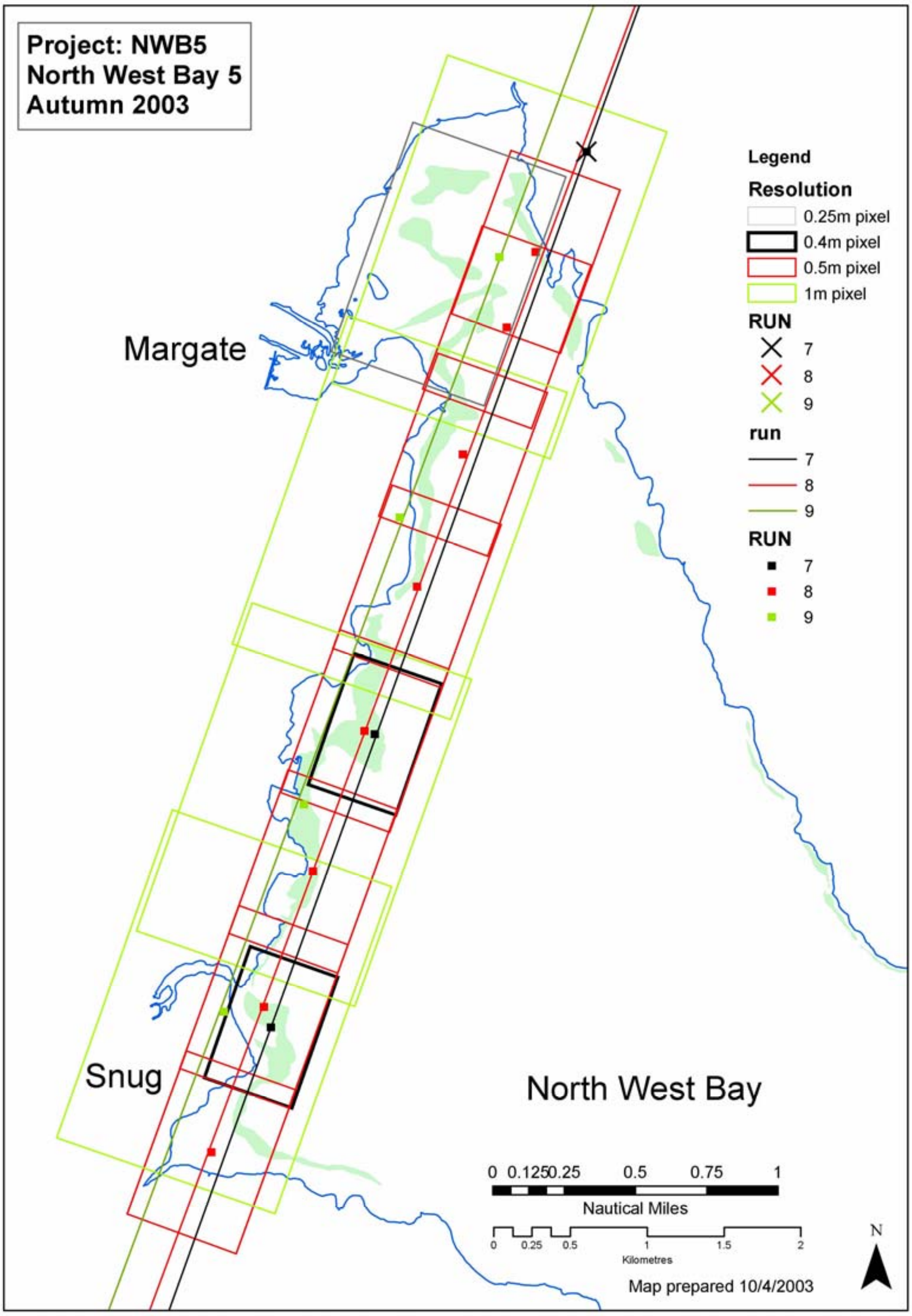


Figure A2-1. North West Bay flight plan

Appendix 3 Sun glitter time window table

Critical Sun Angles in the early morning

From: <http://aa.usno.navy.mil/data/docs/AltAz.html>

To nearest 10 mins

Location: North West Bay - 147° 20' E and 43° 0' S Time Zone 10hrs EST

	EST				Time to 25°	Time to 35°
Date	**Sun rise**	**25°**	**35°**	**Month**	**after Sunrise**	**after 25°**
1/09/2003	6:50	9:20	10:50	**Sep**	2:30	1:30
22/09/2003	**6:10**	**8:30**	**9:30**	**Sep**	**2:20**	**1:00**
1/10/2003	5:50	8:10	9:10	**Oct**	2:20	1:00
22/10/2003	5:20	7:30	8:30	**Oct**	2:10	1:00
1/11/2003	5:00	7:20	8:10	**Nov**	2:20	0:50
22/11/2003	4:40	7:00	7:55	**Nov**	2:20	0:55
1/12/2003	4:30	7:00	7:50	**Dec**	2:30	0:50
22/12/2003	**4:30**	**7:00**	**7:55**	**Dec**	**2:30**	**0:55**
1/01/2003	4:40	7:10	8:00	**Jan**	2:30	0:50
22/01/2003	5:00	7:25	8:20	**Jan**	2:25	0:55
1/02/2003	5:20	7:40	8:30	**Feb**	2:20	0:50
22/02/2003	5:50	8:05	9:00	**Feb**	2:15	0:55
1/03/2003	6:00	8:10	9:10	**Mar**	2:10	1:00
22/03/2003	**6:20**	**8:40**	**9:50**	**Mar**	**2:20**	**1:10**
1/04/2003	6:30	9:00	10:10	**Apr**	2:30	1:10
22/04/2003	7:00	9:40	12:00	**Apr**	2:40	2:20
1/05/2003	7:10	10:00	32° @ noon	**May**	2:50	n/a
22/05/2003	7:30	11:00	26.7 @ noon	**May**	3:30	n/a
1/06/2003	7:40	12:00	25° @ noon	**Jun**	4:20	n/a
22/06/2003	**7:50**	**23.6° @ noon**	**n/a**	**Jun**	**n/a**	**n/a**
1/07/2003	7:50	23.9° @ noon	n/a	**Jul**	n/a	n/a
22/07/2003	7:40	26.6° @ noon	n/a	**Jul**	n/a	n/a
1/08/2003	7:30	10:40	29° @ noon	**Aug**	3:10	n/a
22/08/2003	7:00	9:40	12:00	**Aug**	2:40	2:20

Appendix 4 Benthic video coding protocol

Transcribing codes for video transects - Version 3.3

Updated: 9th May 2005

1. Classification for SEAMAP Tas

Code = class plus modifiers

ie <Class><Substrate_Brightness><Veg_Density><Epiphytic_Loading>

eg zt340 = *Zostera tasmanica* on moderate substrate with dense veg_density (ie >50% blade cover and >75% path cover) and no epiphytes

OR

2. Classification for IMAGERY Analysis

Codes in separate columns

ie <Class><Patch Cover><Veg Density><Epiphytic_Loading><Substrate_Brightness>

CLASS

Note 1: as per SeaMap Tasmania classes down to species level and adding ep

Note 2: ONLY record spp you can definitely see, Dominant first I list

Note 3: add an x at the start of the code to indicate start of video

ss	silty sand
sa	sand
sg	seagrass (if species unknown)
zt	*Zostera tasmanica*
ha	*Halophila australis*
ep	epiphyte
ma	macroalgae (attached)
da	drift algae (associated)

CLASS_MODIFIERS

Veg_Density 1 as per SEAMAP Tasmania Dive Observations method

Note 1: Classes as per SeaMap Tasmania, includes ha, hz and ep

Note 2: blade cover = percent cover

Note 3: patch cover = patch coverage within Field of View of Video ie about 2 x 2 m

Note 4: Therefore use Minimum Mapping Unit of 0.25 m^2 (ie 0.5 x 0.5 m)

-	-	veg density	patch cover
0	none	0%	0%
1	sparse	<50%	no patches
2	sparse patchy	<50%	<5%
3	patchy	>50%	5-75%
4	dense	>50%	>75%
8	unknown		
9	na		

***SAV Structural Density* 2 for IMAGERY (eg Accuracy Assessments) method**

Note 1:	Classes as per SeaMap Tasmania ie includes ha, hz and ep
Note 2:	Video FOV is about 2 x 2 m and one image pixel is about 0.3175 m
Note 3:	Minimum Mapping Unit of 0.25 m^2 (ie 0.5 x 0.5 m)
Note 4:	**Therefore use middle 0.3175 x 0.3175 m portion of video FOV**
Note 5:	patch cover = patch coverage in the middle 0.3175 x 0.3175 m portion of video FOV ie proportion of open substrate to veg
Note 6:	veg density = percent "density" of the veg that is present ie how thick or thin?
Note 7:	Identify patch cover and veg density individually

Patch Cover

Note: For WHOLE "quadrat", assess patch cover of ALL veg to closest 5 or 10%.

Note: very similar to percent canopy cover

0	0%	none
5	5%	extremely small clumps of veg
10	10%	small clumps or single clump
	and so on	
95	95%	small, but discrete patches of substrate showing
100	100%	No substrate showing as discrete patches, but substrate could still be showing through sparse veg.
8	unknown	
9	na	

Vegetation Density

Note: WITHIN the veg patches only, assess veg "thickness" of ALL veg to closest 5 or 10 percent density.

Note: for all veg it refers to integrated "view from above" - how dense, ie how thick or thin?

Note: this measurement is related to biomass within the veg patches.

0	0%	none
5	5%	extremely thin sparse veg
10	10%	sparse or thin
	and so on	
eg 50	50%	moderate density
100	100%	very thick, dense veg
8	unknown	
9	na	

Epiphyte_loading

Note: For WHOLE "quadrat", assess loading of all epiphyte (only) to closest 20%.
Note: NOT As per SeaMap Tasmania, gauge it whether seagrass
(ie ha and hz) is apparent or not.

0	none	none
1	<20%	very light cover
2	20-40%	low cover epiphyte or single clump
3	40-60%	half and half
4	60-80%	solid but patchy epiphyte
5	80-100%	solid thick epiphyte
8	unknown	
9	na	

Substrate_Brightness

Note: Doesn't include veg

1	very bright
2	bright
3	moderate
4	dark
5	very dark
8	unknown
9	na

Edge and Match Characteristics

Note: range of inter-class changes = 1-19 and intra-class changes 21 - ?

EDGE_TYPE	
0	no edge
1	ss and ha
2	ss and zt
3	ss and ep
4	sa and ha
5	sa and zt
6	sa and ep
7	ep and ha
8	ep and zt
9	ha and zt
88	unknown
99	na

Intra-class changes	
21	ss to ss
22	sa to sa
23	ha to ha
24	zt to zt
25	ep to ep

Note: Contrast across class boundary estimated with a general greyscale

CONTRAST		
0	none	no apparent contrast
1	low	limited contrast
2	moderate	moderate contrast
3	high	clear, high contrast
8	unknown	
9	na	

GRADIENT		Note: Gradient across class boundary
1	abrupt	very clear edge
2	clear	obvious edge
3	patchy	interspersed fairly dense patches
4	gradual	slow increase in new class
8	unknown	
9	na	

MATCH		Note: Is there a match of the edge point in video to an edge in imagery?
0	no	
1	yes	
2	uncertain	

M_DIST		Note: Distance between matched edge points
#	metres	
99	na	

M_DIR		Note 1: Direction from edge point in video and matched edge in imagery Note 2: Aim is to see if error is consistently in one direction approx degrees from grid north to nearest 25 to 45 degrees.
0 to 360	degrees	
8	unknown	
9	na	

DEEP_EDGE		Note: Is this a deep edge boundary?
0	no	
1	deepest (in video)	
2	deepest (in image)	

Benthic Video Coding Example

DATE	TIME	COMMENT	FROM	TO	DEPTH	EDGE TYPE	GRADIENT	CONTRAST	MATCH	M_DIST	M_DIR
7/02/2003	13:32:44	start	ep229	xep229	6.9						
7/02/2003	13:33:45			zt221	5.1	16	2	2	1	0	8
7/02/2003	13:34:39			sa200	3.8	14	2	2	0		
7/02/2003	13:34:52			zt211	2.7	14	3	2	1	4	20
7/02/2003	13:35:03			zt222	2.7		3	1	0		
7/02/2003	13:35:36			zt942	3.9		3	2	1	4	350
7/02/2003	13:35:40	corner		ht222	3.9		2	1	0		
7/02/2003	13:36:13			ha934	3.9	17	3	1	0		
7/02/2003	13:36:26			ha932	4.2		3	1	0		
7/02/2003	13:36:50			ha932ep249	4.5		4	1	0		
7/02/2003	13:37:50			ha932ep249zt213	5.0	17	3	0	1	6	270
7/02/2003	13:39:12			ep229	5.7	16	2	2	1	0	9
7/02/2003	13:39:24	stop			5.9						

Appendix 5 Tidal correction for single beam soundings

Correcting depth measurements for tidal influence

Source: Miles Lawler, TAFI, 2003
Modified: Richard Mount, CenSIS/TAFI, 8/5/2004

1. Normalisation of the field data to the chart datum

The depth correction allows the normalisation of the field data to the chart datum. This means the corrected data represent the bottom in relation to the datum and allow the creation of consistent DEMs and proper comparison of depths and depth related data whatever the tidal state at the time of data collection. Note that the original field data is collecting the actual water depth at the time of acquisition. This means that the corrected water depth can be shallower than the draft of the boat.

The ebb and flow of the tides will mean that water depth at any location will vary over the tidal cycle. Depending on the coastal region this variation can be in the order of tens of centimetres to meters over a variable six-hour period. Tide height is also affected by meteorological events differing from the average, such as strong prevailing wind, barometric pressure and floods in estuarine environments. While meteorological events do cause tide heights to vary from the predicted tide heights, the magnitude of this variation will generally not change over the course of a day. Provided the weather is close to average, there will be little variation from the predicted tide heights found in published tide tables. Due to problems in accurately quantifying these meteorological effects, they have been excluded from the method used here.

Tidal correction is based on the tidal tables produced by Flinders University (Flinders University, 2001). These are based on 160 components used to calculate the tidal cycle for standard ports. The tidal cycle can be described by a harmonic equation.

The following formula was applied to the depth data collected in the field align it to the reference datum:

Datum corrected field data = field data + depth correction

where depth correction = (chart datum - height at datum mark now)

where chart datum = 1.2 m (@ Hobart)

height at datum mark now = $h_1+((h_2-h_1)*(COS(PI()*((t-t_1)/(t_2-t_1)+1))+1))/2$

where h_1 = height of the tide preceding the depth measurement being corrected
h_2 = height of the tide following the depth measurement being corrected
t = time of the depth measurement being corrected
t_1 = time of the tide preceding the depth measurement being corrected
t_2 = time of the tide following the depth measurement being corrected

Note: h_1, h_2, and t_1, t_2 are obtained from published tide tables (Flinders University, 2001).

"Height at datum mark now" formula explanation

The **purple** part calculates the change in tide height at the location of the datum over the rise or fall of tidal cycle (low to high or high to low)

The **orange** part calculates the proportional position in the tidal cycle at time 't'

The **purple** and **orange** parts are multiplied together to give the change in height at the location of the datum at time 't' from the initial height

This is added to the **pink** initial height (h_1) to give the instantaneous tide height at time 't' at the location of the datum ie "height at datum mark now" or "datum_now".

From JMP:

chart_datum - (tidalCycle1_h1 + ((tidalCycle1_h2 - tidalCycle1_h1) * (Cosine(Pi() * ((:Name(" Ping_time") - tidalCycle1_t1) / (tidalCycle1_t2 - tidalCycle1_t1) + 1)) + 1)) / 2)

2. Image adjusted DEM

The DEM created from datum corrected field data needs to be height adjusted for each image as each image is captured at a particular moment of the tidal cycle. This is, in effect, the reverse of the datum correction process but is applied across the whole DEM at once for each image as follows:

Image adjusted DEM value = datum corrected value + image depth adjustment

Where DEM depth values are expressed in the negative (eg –1.2 m) then

Image depth adjustment = (chart datum - height at datum mark now)

otherwise,

Image depth adjustment = (height at datum mark now - chart datum)

Appendix 6 SEAMAP Tasmania JMP (SAS) tidal correction formula template

Originally sourced from: GB_depth_2005_03_22_23_24_wgs84.JMP

1. Ensure "Ping_time" exists as a column name for time (NOTE: you need to know if it is EST or DST!!!).
2. The formula is between the tildes (~~~~~) below.
3. Set up the chart datum, tide height (h) and tide time (t) and tide date (day) parameters in the first part of the formula. Create a column called "tidal_correction", then copy and paste formula between the tildes into this column's formula property. The formula calculates the tidal correction. You then ADD this correction to the original depth in a new column called "corrected_depth" or similar.
    a. The chart_datum parameter refers to the chart datum for the local area.
    b. The parameters listed first are in metres and refer to the depth of the high or low before and after each ping time.
    c. The time parameters are in 24-hour time (hh:mm:ss) and similarly refer to the time of the high or low before and after each ping time. You MUST set your PC clock to 24-hour time as well!
    d. The day parameters must also match the tidal cycles in the body of the main formula. You need to change the day number to the one on which the tidal cycle occurs.

Note here where the correction is for etc and save off a copy for future reference or repeated efforts rather than using this template file.

~~~~~~

```
Parameter({
chart_datum = 0.59,

tidalCycle1_t1 = 07:31:00,
tidalCycle1_h1 = 0.9,
tidalCycle1_t2 = 15:11:00,
tidalCycle1_h2 = 0.2,

tidalCycle2_t1 = 15:11:00,
tidalCycle2_h1 = 0.2,
tidalCycle2_t2 = 20:48:00,
tidalCycle2_h2 = 0.8,

tidalCycle3_t1 = 08:20:00,
tidalCycle3_h1 = 1,
tidalCycle3_t2 = 15:44:00,
tidalCycle3_h2 = 0.2,

tidalCycle4_t1 = 15:44:00,
tidalCycle4_h1 = 0.2,
tidalCycle4_t2 = 21:25:00,
tidalCycle4_h2 = 0.8,

day1 = 22Mar2005,
day2 = 23Mar2005,
```
~~~~~~

```
day3 = 24Mar2005},

If(

tidalCycle1_t1 <  :Ping_time <= tidalCycle1_t2 &  :Ping_date == day1,

chart_datum - (tidalCycle1_h1 + ((tidalCycle1_h2 - tidalCycle1_h1) * (Cosine(Pi() * ((
:Ping_time - tidalCycle1_t1) / (tidalCycle1_t2 - tidalCycle1_t1) + 1)) + 1)) / 2),


tidalCycle2_t1 <  :Ping_time <= tidalCycle2_t2 &  :Ping_date == day1,

chart_datum - (tidalCycle2_h1 + ((tidalCycle2_h2 - tidalCycle2_h1) * (Cosine(Pi() * ((
:Ping_time - tidalCycle2_t1) / (tidalCycle2_t2 - tidalCycle2_t1) + 1)) + 1)) / 2),


tidalCycle3_t1 <  :Ping_time <= tidalCycle3_t2 &  :Ping_date == day2,

chart_datum - (tidalCycle3_h1 + ((tidalCycle3_h2 - tidalCycle3_h1) * (Cosine(Pi() * ((
:Ping_time - tidalCycle3_t1) / (tidalCycle3_t2 - tidalCycle3_t1) + 1)) + 1)) / 2),


tidalCycle4_t1 <  :Ping_time <= tidalCycle4_t2 &  :Ping_date == day2,

chart_datum - (tidalCycle4_h1 + ((tidalCycle4_h2 - tidalCycle4_h1) * (Cosine(Pi() * ((
:Ping_time - tidalCycle4_t1) / (tidalCycle4_t2 - tidalCycle4_t1) + 1)) + 1)) / 2),

999999))
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Appendix 7 Digital camera CCD dimensions

From Digital Photography Review
<http://www.dpreview.com/news/0210/02100402sensorsizes.asp>
Accessed 6 October 2003

		Tube	**Sensor (mm)**		
Type	**Aspect Ratio**	**Dia. (mm)**	Width (x)	Height (y)	Diagonal
1/3.6"	4:3	7.056	4	3	5
1/3.2"	4:3	7.938	4.536	3.416	5.68
1/3"	4:3	8.467	4.8	3.6	6
1/2.7"	4:3	9.407	5.27	3.96	6.592
1/2"	4:3	12.7	6.4	4.8	8
1/1.8"	4:3	14.11	7.176	5.319	8.933
2/3"	4:3	16.93	8.8	6.6	11
1"	4:3	25.4	12.8	9.6	16
4/3"	4:3	33.87	18	13.5	22.5
APS-C	3:2	n/a	25.1	16.7	30.1
35 mm	3:2	n/a	36	24	43.3
645	4:3	n/a	56	41.5	69.7

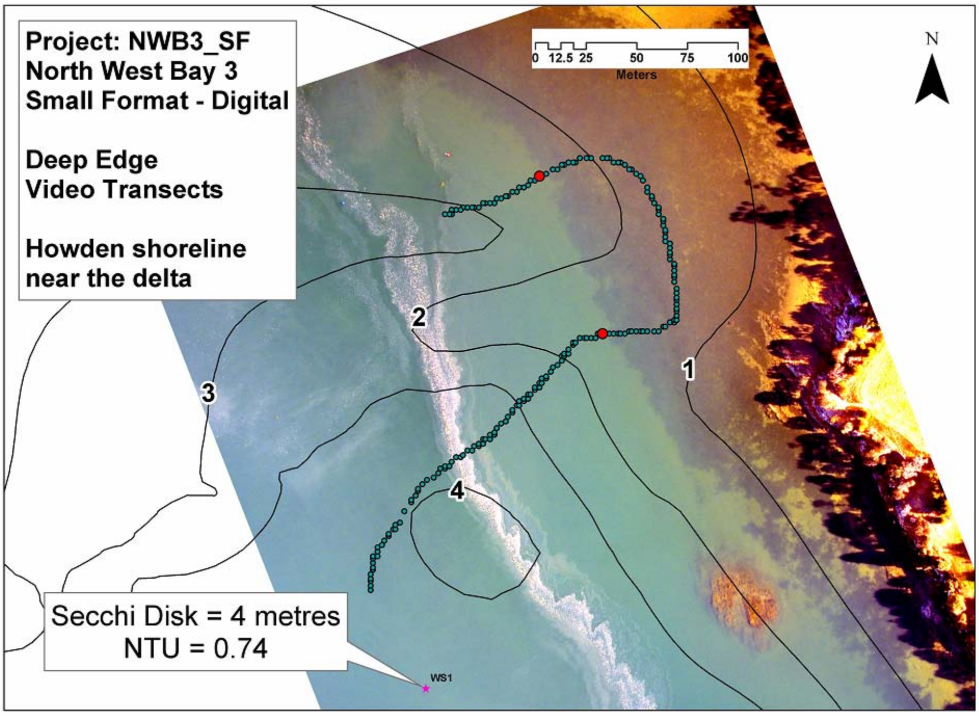
Info Source	**CCD old sizes**	**Width**	**Height**	**Diagonal**	**Proportion**
Mark Shapiro					
	1/3	4.8	3.6	6	0.75
	1/2	6.4	4.8	8	0.75
	2/3	8.8	6.6	11	0.75
	1	12.7	9.5	15.86001261	0.748031496
Spectra Service					
	1/3	4.8	3.6	6	0.75
	1/2	6.4	4.8	8	0.75
	2/3	8.8	6.6	11	0.75
	1	12.8	9.6	16	0.75
PPN					
	1/3	4.8	3.6	6	0.75
	1/2	6.4	4.8	8	0.75
WPI Inc					
	1/4			4	
	1/3			6	
	1/2			8	
	2/3			11	

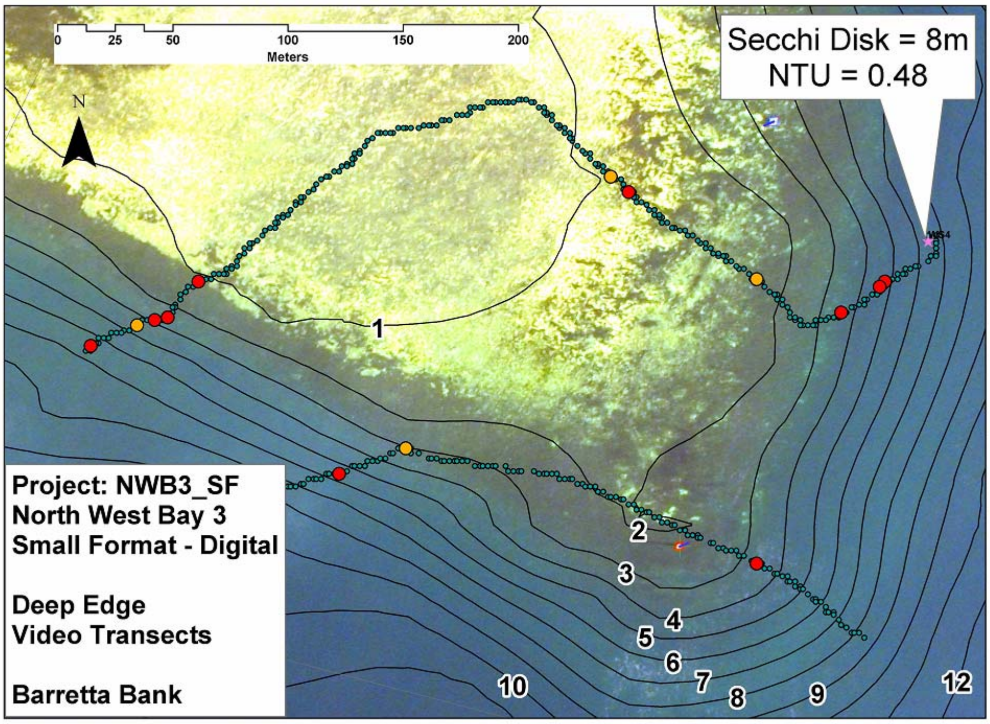
Appendix 8 Camera lens FOV comparisons

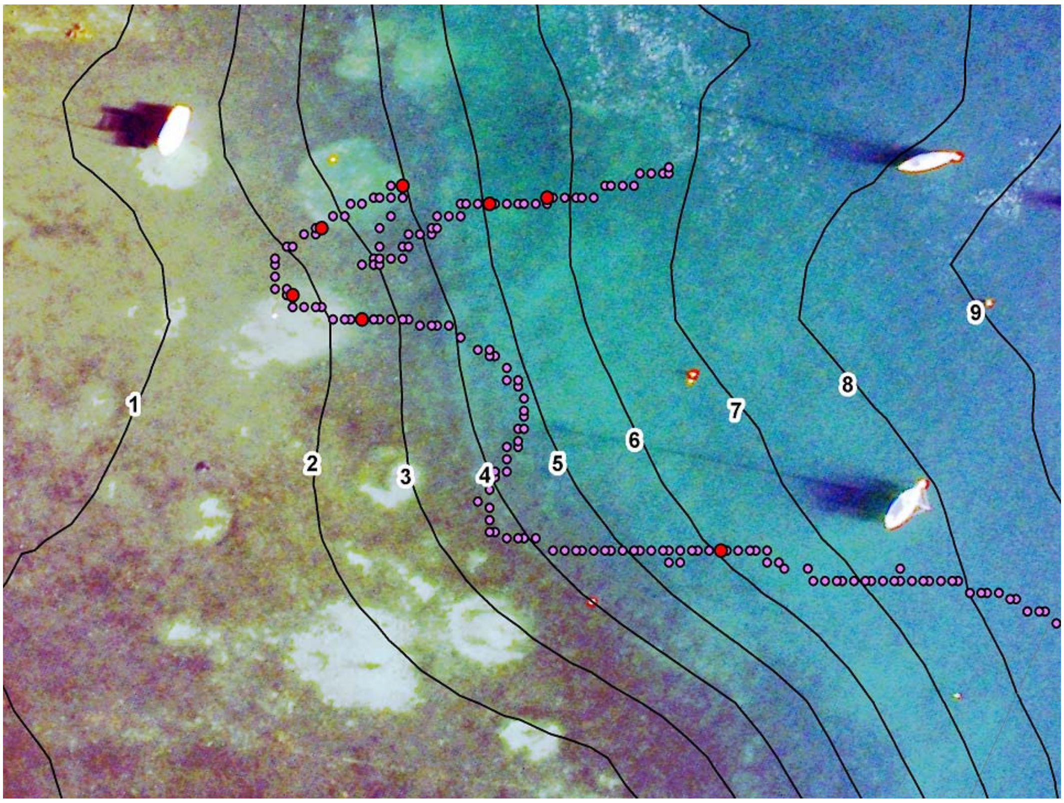
Camera	Lens	Neg/CCD Size (mm)			FOV °					
	(f) mm	x	y	diag	cnr angle°	x	y	angular	half angle	Angle Description
Reference only										
Super Wide Angle								~120 °	~60°	Super Wide
Wide Angle								~90 °	~45°	Wide
Normal Angle								~60 °	~30°	Normal
Zeiss RMK/A	152.963	230	230	325.269	45.0000	73.87°	73.87°	93.51°	46.76°	Wide
	305	230	230	325.269	45.0000	41.32°	41.32°	56.14°	28.07°	Normal
Canon EOS D30	24	22.7	15.1	27.264	56.3682	50.62°	34.93°	59.19°	29.60°	Normal
	50	22.7	15.1	27.264	56.3682	25.58°	17.17°	30.50°	15.25°	Limited
Leica	24	36	24	43.267	56.3099	73.74°	53.13°	84.06°	42.03°	Wide
	35	36	24	43.267	56.3099	54.43°	37.85°	63.44°	31.72°	Normal
	50	36	24	43.267	56.3099	39.60°	26.99°	46.79°	23.40°	Normal
35mm equivalent	38	36	24	43.267	56.3099	50.69°	35.05°	59.31°	29.65°	Normal
	152	36	24	43.267	56.3099	13.51°	9.03°	16.20°	8.10°	Telephoto
Wide Angle Lenses	5.44	8.043	5.93	9.993	53.5991	72.95°	57.18°	85.13°	42.57°	Wide
	5.28	8.043	5.93	9.993	53.5991	74.59°	58.63°	86.84°	43.42°	Wide
	5.04	8.043	5.93	9.993	53.5991	77.17°	60.94°	89.50°	44.75°	Wide

Appendix 9 Imagery and benthic video tracklogs

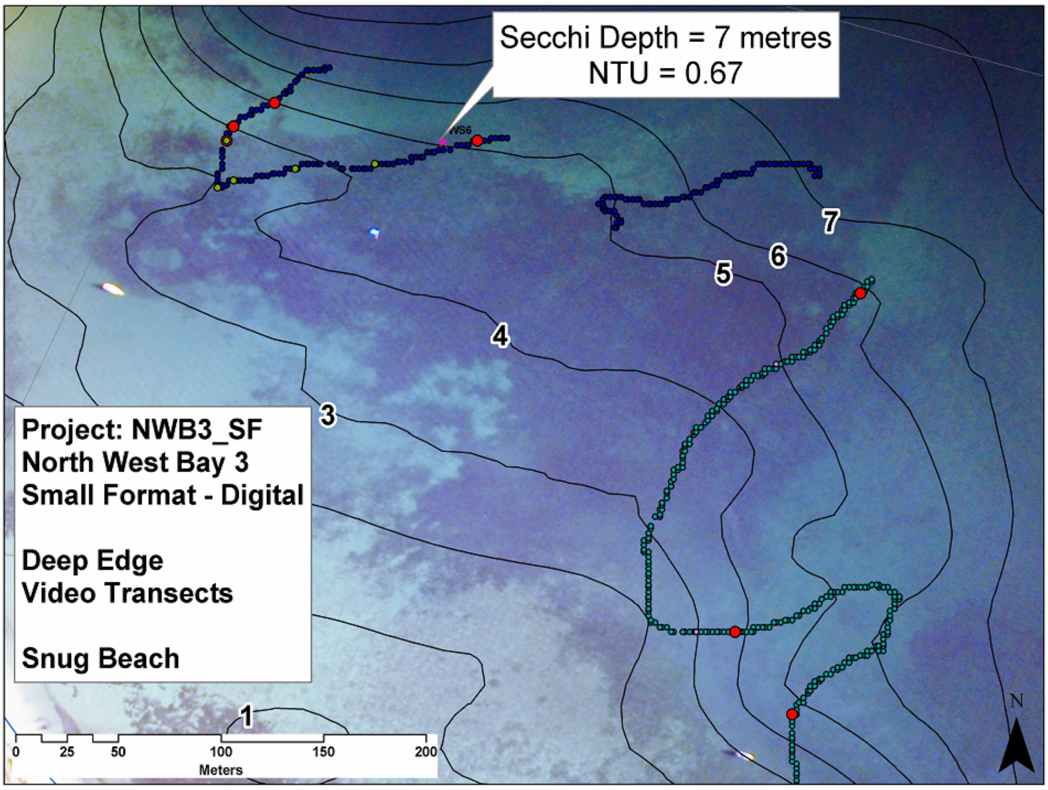
The following images represent four of the five sample sites in North West Bay for Chapter 4 and are presented in order from from north to south. Red points represent seagrass/sand boundaries detected in the benthic video using the Benthic Video Coding Protocol defined in Appendix 4. The orange points represent boundaries within the same habitat type.







1
2
3
4
5
6
7
8
9



Secchi Depth = 7 metres
NTU = 0.67
WS6
7
6
5
4
3
1
Project: NWB3_SF
North West Bay 3
Small Format - Digital
Deep Edge
Video Transects
Snug Beach
0
25
50
100
150
200
Meters
N